Exposure of the coronary artery using an ultrasonic scalpel

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It has been reported that an ultrasonic scalpel (Harmonic Scalpel, dissecting-hook type; Ethicon Endo-Surgery, Cincinnati, Ohio) allows surgeons to exfoliate the internal thoracic artery without thermal injury to grafts and to collect skeletonized grafts that provide long-term patency.[1-4] During coronary artery bypass surgery, exposure of native coronary arteries is occasionally a problem when they are buried in adipose tissue or myocardium. We verified that the ultrasonic scalpel can provide safe and rapid exposure of coronary arteries.

Materials and Methods

We exposed three coronary arteries located in adipose tissue or myocardium of 3 anesthetized swine under beating-heart conditions with an ultrasonic scalpel. A regular scalpel was used to make an incision in the epicardium. For coronary arteries in adipose tissue, contact time between the ultrasonic scalpel and arteries was reduced by using a "quick touch" method.[4] For coronary arteries located in myocardium, we moved the blade of the ultrasonic scalpel gradually along the direction in which arteries were believed to run in a rubbing manner because it was necessary to solidify myocardial proteins on the surface. The swine heart was extracted, and specimens were obtained in the direction of the minor axis in the medial portion and in the anteroposterior major axis of each exfoliated coronary artery. Thermal injuries (abnormal findings in the tunica media and tunica externa) were examined with four staining methods: hematoxylin-eosin staining; Azan staining for cytoplasm and elastic and collagen fibers; Masson trichrome staining; and Elastica von Gieson staining specific for elastic fibers.

All animals received humane care in compliance with the "Guide for the Care and Use of Laboratory Animals" published by the National Institutes of Health (NIH Publication No. 85-23, revised 1985).

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Results

Coronary arteries located in adipose tissue were identified easily with an ultrasonic scalpel along the direction in which arteries were anticipated to run, and we were able to expose enough of the length of arteries for anastomosis in a short time (approximately 1 minute). A limited number of arrhythmias were observed during the procedures. We gradually exfoliated coronary arteries in the myocardium, starting from the exposed portions. There was little bleeding from the myocardium. No thermal denaturation reached the vessel wall (tunica externa), which resulted in no indicative findings in any staining except hematoxylin-eosin staining. Thermal denaturation was observed only in circumferential connective tissue, without reaching the coronary arteries, in arteries located in both adipose tissue and myocardium. The distance between connective tissue and coronary arteries was 0.2 to 0.6 mm. Normal neurons were found in the tissue with partial thermal denaturation (Figure 1).

Comment

Utility of an ultrasonic scalpel for collecting skeletonized grafts in coronary artery bypass surgery has been reported. The device is believed to have advantages in extending grafts and increasing rates of complete arterial revascularization.[2-4] In addition, patency of the vessel seems adequate. Further, exposing coronary arteries running in adipose tissue or myocardium may be slow or result in secondary injuries, including ventricular perforation. We therefore evaluated whether an ultrasonic scalpel would expose coronary arteries with little bleeding and verified its safety by histologic examination.

Exposure of coronary arteries running in adipose tissue was easy with the ultrasonic scalpel. Coronary arteries were easily identified by moving the blade horizontally to reduce the thickness of adipose tissue in a wide region, and we believe that arrhythmias were inhibited by avoiding direct vertical power to the myocardium during the procedure. Coronary arteries in myocardium were exposed by gradual exfoliation, starting from coronary arteries running on the myocardial surface. Also ultrasound can indicate direction and depth of arteries prospectively, which could lead to safer graft collection. A few arrhythmias were observed, because some incision of the myocardium was necessary; however, there were no morbid arrhythmias. No thermal denaturation was found in arterial specimens. In some reports, arterial grafts harvested with a similar procedure showed no thermal denaturation, and long-term patency was good. The ultrasonic scalpel is thought to be safe because no denaturation on coronary arteries was observed. Traditionally,

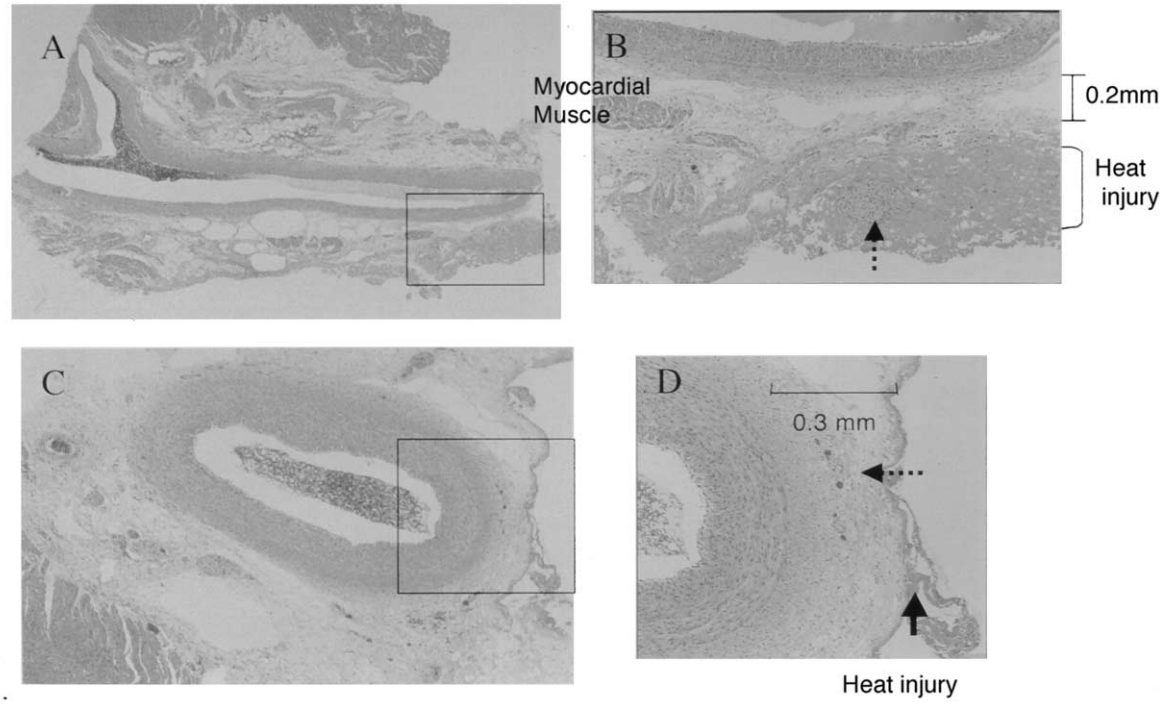

Figure 1. ***A,*** **Hematoxylin-eosin stain of specimens. Coronary artery running in myocardium.** ***B,*** **Higher magnification of boxed area in part** ***A.*** **Normal neuron is observed in tissue with thermal denaturation.** ***C,*** **Coronary artery running in adipose tissue.** ***D,*** **Higher magnification of boxed area in part** ***C.*** **No thermal denaturation is seen in coronary arteries. Distances between connective tissue and coronary arteries were 0.2 to 0.6 mm.** ***Dotted arrows*** **indicate normal neuron;** ***arrow*** **indicates heat injury.**

the Cavitron ultrasonic aspirator has been used to expose coronary arteries. However, we believe that using an ultrasonic scalpel properly causes less damage to the myocardium than does the ultrasonic aspirator, which uses vertical power. The ultrasonic scalpel can prevent us from having to prepare a new device because it can be used continuously for collection of grafts.

On the basis of our findings, we believe that it is easy and safe to expose coronary arteries buried in adipose tissue and myocardium with an ultrasonic scalpel that avoids thermal denaturation. We report our histologic results concerning safety because no previous verification has been reported.

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